# PART 3
# "V-TYPE" PREPACKAGED TRANSFER SWITCHES

## Air-cooled, Prepackaged Automatic Standby Generators

**Models:**
**04389, 04758 (6 kW NG, 7 kW LP)**
**04456, 04759 (12 kW NG, 12 kW LP)**
**04390, 04760 (13 kW NG, 15 kW LP)**

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## *GENERAL*

The prepackaged, "V-Type" transfer switch is rated 100 amps at 250 volts maximum. It is available in 2-pole configuration only and, for that reason, is useable with 1-phase systems only.

Prepackaged transfer switches do not have an intelligence system of their own. Instead, automatic operation of these transfer switches is controlled by a circuit board housed in the generator control panel.

## *ENCLOSURE*

The standard prepackaged, "V-Type" transfer switch enclosure is a NEMA 1 type ("NEMA" stands for "National Electrical Manufacturer's Association"). Based on NEMA Standard 250, the NEMA 1 enclosure may be defined as one that is intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment and where unusual service conditions do not exist.

| **ITEM** | **DESCRIPTION** |
|---|---|
| 1 | BOX GTS LOAD CENTER |
| 2 | COVER, 12 POSITION GTS LOAD CENTER |
| 3 | TRANSFER SWITCH HOME STANDBY 100A2P250V |
| 4 | SCREW TAPTITE M5-0.8 X 10 BP |
| 5 | SCREW TAPTITE 1/4-20 X 5/8 BP |
| 6 | LOCK WASHER, SPECIAL-1/4" |
| 7 | RELAY PANEL 12VDC DPDT 10A@240VA |
| 8 | BASE, MOUNTING 12 CIRCUIT 125A/240V |
| 9 | SCREW TAPTITE M4-0.7X10 BP |
| 10 | RIVET POP .156 X .160-.164/#20 |
| 11 | WASHER FLAT 1/4 ZINC |
| 12 | PLUG |
| 13 | HARNESS ADAPTER PLATE |
| 14 | PANEL-SUB BREAKER BASE |
| 15 | TRIM VINYL BLACK 1/8GP |
| 16 | WASHER LOCK #10 |
| 17 | NUT WING M6-1.0 |
| 18 | HANDLE, TRANSFER SWITCH HOME STANDBY |
| 19 | HOLDER CABLE TIE |
| 21 | LUG DIS QK NI-S 10X45 DEG BR/T |
| 22 | SCREW PPHM #10-32 X 1/4 |
| 23 | LUG SLDLSS 1/0-#14X9/16 AL/CU |
| 24 | BLOCK TERMINAL 20A 5 X 6 X 1100V |
| 25 | TIE WRAP 3.9" X .10" NAT'L UL |
| 26 | WASHER FLAT #8 ZINC |
| 27 | COVER, RELAY & TERM BLOCK |
| 28 | WIRE HARNESS,GTS LOAD CENTER (NOT SHOWN FOR CLARITY) |
| 29 | FUSE HOLDER |
| 30 | ASSEMBLY FUSE 5A X BUSS HLDR73591 |
| 31 | PCB SUPPORT SNAP-IN 1-3/8" |
| 32 | CIRCT BRK 20 X 1 HOM120 |
| 33 | CIRCT BRK 20 X 2 HOM220 |
| 34 | CIRCT BRK 15 X 1 HOM115 |
| 35 | CIRCT BRK 30 X 2 HOM230 |
| 36 | COVER - HARNESS ENTRY |
| 37 | HARNESS, GTS TO EXT CONN BOX |
| 38 | WASHER LOCK M4 |
| 39 | SCREW SW 1/4-20X5/8 N WA JS500 |
| 40 | SCREW SWAGE 1/4-20 X 1/2 ZINC |
| 41 | SCREW PPHM M4-0.7 X 10 |
| 42 | HARNESS,GTS TO MAIN PANEL |

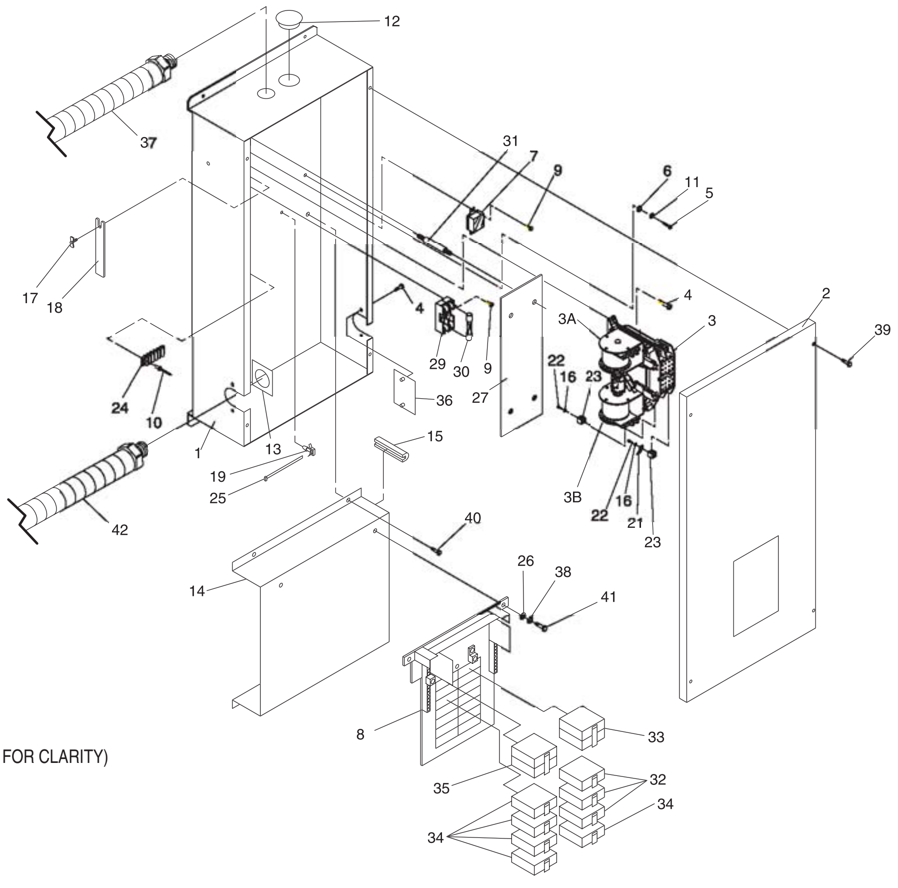


*Figure 1. Exploded View of V-Type Prepackaged Transfer Switch*

## *TRANSFER MECHANISM*

The 2-pole transfer mechanism consists of a pair of moveable LOAD contacts, a pair of stationary UTILITY contacts, and a pair of stationary STANDBY contacts. The load contacts can be connected to the utility contacts by a utility closing coil; or to the standby contacts by a standby closing coil. In addition, the load contacts can be actuated to either the UTILITY or STANDBY side by means of a manual transfer handle. See Figures 2 and 3.

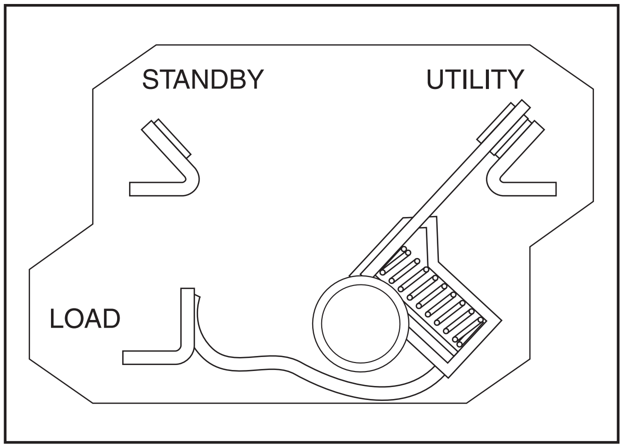


*Figure 2. Load Connected to Utility Power Source*

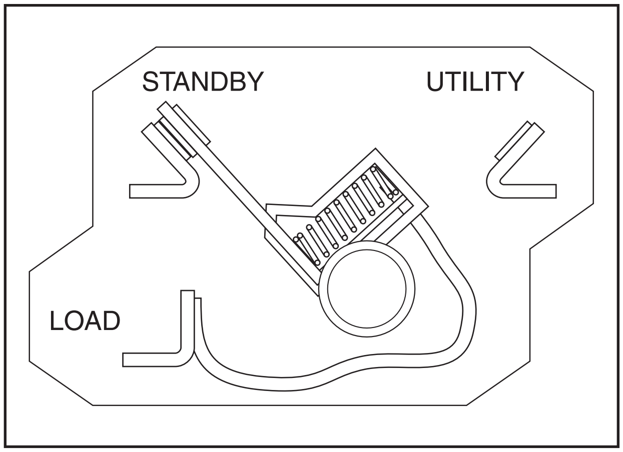


*Figure 3. Load Connected to Standby Power Source*

UTILITY CLOSING COIL C1:

See Figure 4. This coil is energized by rectified utility source power, to actuate the load contacts to the UTILITY power source side. When energized, the coil will move the main contacts to an "overcenter" position. A limit switch will then be actuated to open the circuit and spring force will complete the retransfer to STANDBY. A bridge rectifier, which changes the utility source alternating current (AC) to direct current (DC), is sealed in the coil wrappings. If coil or bridge rectifier replacement becomes necessary, the entire coil and bridge assembly should be replaced.

STANDBY CLOSING COIL C2:

Coil C2 is energized by rectified standby source power, to actuate the load contacts to their "Standby" source side. Energizing the coil moves the load contacts to an overcenter position; limit switch action then opens the circuit and spring force will complete the transfer action to "Standby". This coil's bridge rectifier is also sealed in the coil wrappings. Replace the coil and bridge rectifier as a unit.

LIMIT SWITCHES XA1 AND XB1:

Switches are mechanically actuated by load contacts movement. When the load contacts are connected to the utility contacts, limit switch XA1 opens the utility circuit to utility closing coil C1 and limit switch XB1 closes the standby circuit to standby closing coil C2. The limit switches "arm" the system for retransfer back to UTILITY when the load contacts are connected to the STANDBY side. Conversely, when the load contacts are connected to the UTILITY side, the switches "arm" the system for transfer to STANDBY. An open condition in limit switch XA1 will prevent retransfer to "Utility". An open switch XB1 will prevent transfer to STANDBY.

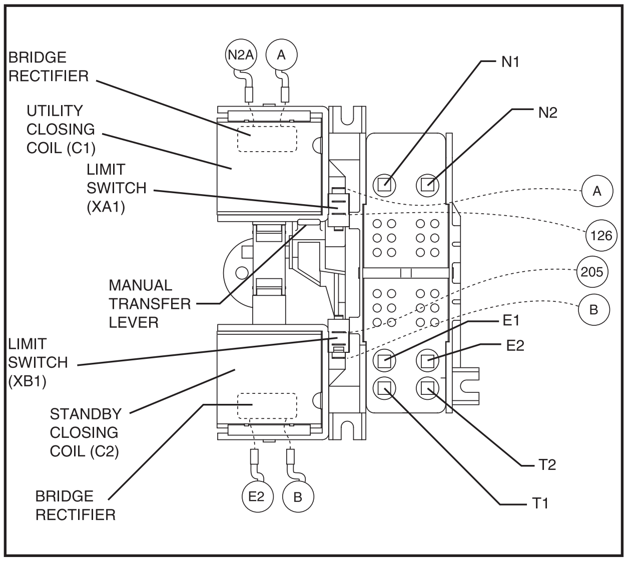


*Figure 4. The "V-Type" Transfer Mechanism*

## TRANSFER RELAY

Transfer relay operation is controlled by a circuit board. That circuit board is a part of a control panel assembly, mounted on the standby generator set.

Figure 5 shows the transfer relay pictorially and schematically. Relay operation may be briefly described as follows:

1. Generator battery voltage (12 volts DC) is available to the transfer relay coil from the generator circuit board, via Wire 194 and relay terminal A.
   a. The 12 volts DC circuit is completed through the transfer relay coil and back to the generator circuit board, via Wire 23.
   b. Circuit board action normally holds the Wire 23 circuit open to ground and the relay is de-energized.
   c. When de-energized, the relay's normally open contacts are open and its normally-closed contacts are closed.
   d. The normally-closed relay contacts will deliver utility source power to the utility closing circuit of the transfer mechanism.
   e. The normally open relay contacts will deliver standby source power to the transfer mechanism's standby closing circuit.

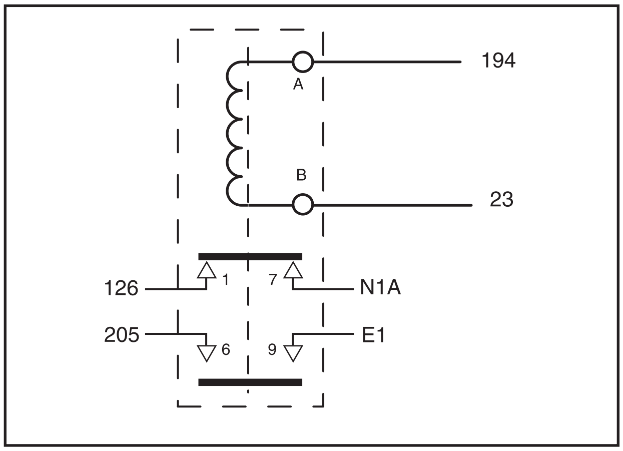


*Figure 5. Transfer Relay Schematic*

2. During automatic system operation, when the generator circuit board "senses" that utility source voltage has dropped out, the circuit board will initiate engine cranking and startup.
3. When the circuit board "senses" that the engine has started, an "engine warm-up timer" on the circuit board starts timing.
4. When the "engine warm-up timer" has timed out, circuit board action completes the Wire 23 circuit to ground.
   a. The transfer relay then energizes.
   b. The relay's normally-closed contacts open and its normally open contacts close.
   c. When the normally open contacts close, standby source power is delivered to the standby closing coil and transfer to "Standby" occurs.
5. When the generator circuit board "senses" that utility source voltage has been restored above a preset level, the board will open the Wire 23 circuit to ground.
   a. The transfer relay will de-energize, its normally-closed contacts will close and its normally open contacts will open.
   b. When the normally-closed relay contacts close, utility source voltage is delivered to the utility closing coil to energize that coil.
   c. Retransfer back to UTILITY occurs.

## NEUTRAL LUG

The standby generator is equipped with an UNGROUNDED neutral. The neutral lug in the transfer switch is isolated from the switch enclosure.

## MANUAL TRANSFER HANDLE

The manual transfer handle is retained in the transfer switch enclosure by means of a wing stud. Use the handle to manually actuate the transfer mechanism load contacts to either the UTILITY or STANDBY source side.

Instructions on use of the manual transfer handle may be found in Part 5, "Operational Tests and Adjustments".

## TERMINAL BLOCK

During system installation, this 5-point terminal block must be properly interconnected with an identically labeled terminal block in the generator control panel assembly.

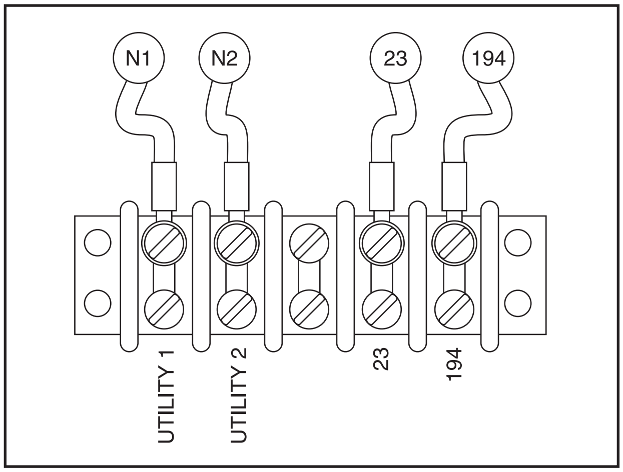


*Figure 6. Transfer Switch Terminal Block*

Terminals used on the terminal block are identified as Utility 1 and 2; 23 and 194.

UTILITY 1 AND 2:

Interconnect with identically labeled terminals in the generator control panel assembly. This is the utility voltage signal to the circuit board. The signal is delivered to a step-down transformer in the control module assembly and the resultant reduced voltage is then delivered to the circuit board. UTILITY 1 and 2 power is used by the circuit board as follows:

- ❏ If utility source voltage should drop below a preset level, circuit board action will initiate automatic cranking and startup, followed by automatic transfer to the standby source.
- ❏ Utility source voltage is used to operate a battery trickle charge circuit which helps to maintain battery state of charge during non-operating periods.

TERMINALS 23 AND 194:

These terminals connect the transfer relay to the generator circuit board. See "Transfer Relay" on Page 3.1-2.

## *FUSE HOLDER*

The fuse holder holds two (2) fuses, designated as fuses F1 and F2. Each fuse is rated 5 amperes.

FUSES F1, F2:

These two fuses protect the terminal board UTILITY 1 and 2 circuit against overload.

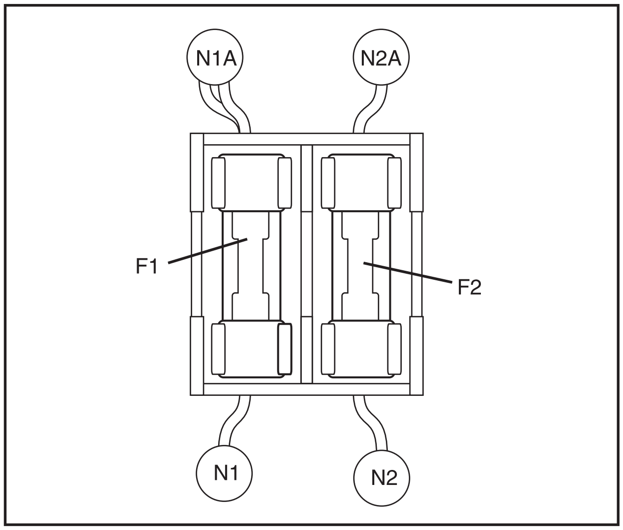
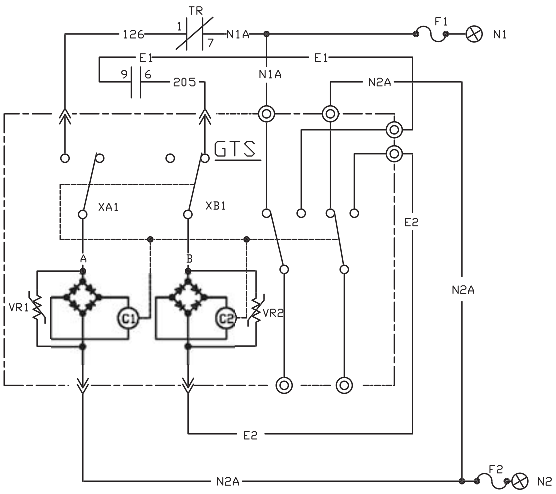


*Figure 7. The Fuse Holder*

## *OPERATIONAL ANALYSIS*

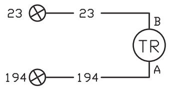
Figure 1 is a schematic and wiring diagram for a typical "V-Type" transfer switch.

**SCHEMATIC DIAGRAM**



**LEGEND**

**C1- SOLENOID COIL (UTILITY CLOSING)**
**C2- SOLENOID COIL (STANDBY CLOSING)**
**GTS - TRANSFER SWITCH CONTACTOR**
**TR - RELAY, TRANSFER**
**TS - TERMINAL STRIP (CUSTOMER CONNECTION)**
**XA1, XB1- LIMIT SWITCHES, ACTUATOR**
**F1, F2 - FUSE, 5A SENSING**
**VR1, VR2 - VARISTOR**



**NOTE:**
**ALL CONTACTS SHOWN WITH TRANSFER SWITCH IN UTILITY POSITION.**

**WIRING DIAGRAM**

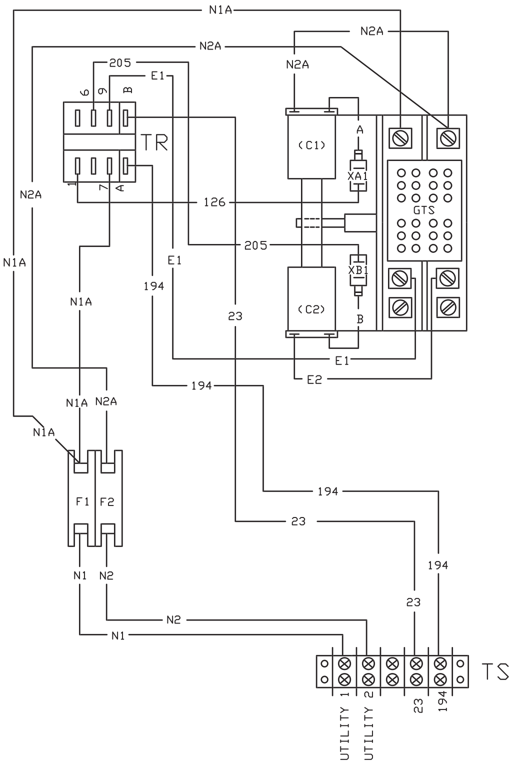
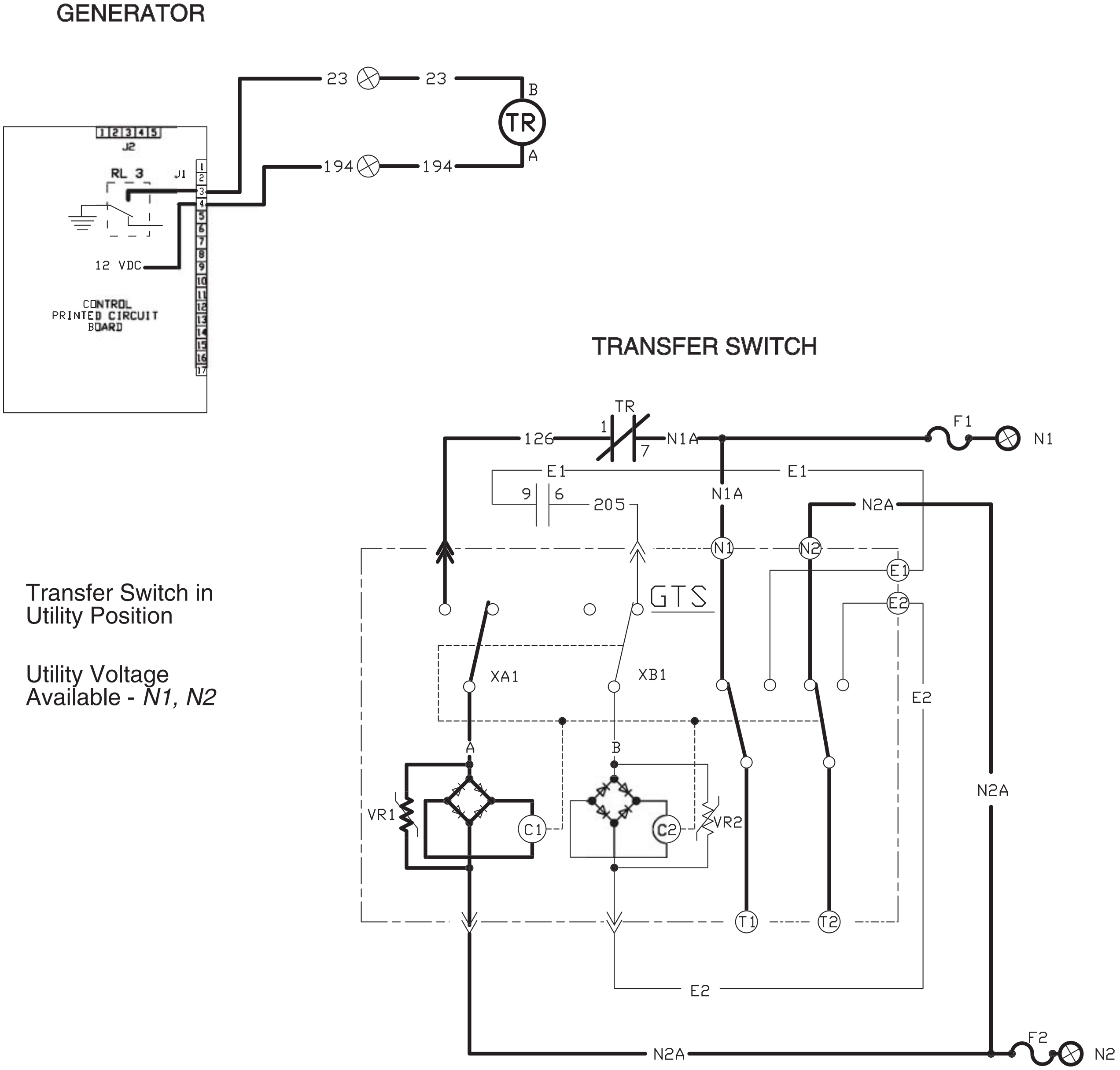


*Figure 1. Wiring Diagram and Schematic*

## *UTILITY SOURCE VOLTAGE AVAILABLE*

Figure 2 is a schematic representation of the transfer switch with utility source power available. The circuit condition may be briefly described as follows:

- ❏ Utility source voltage is available to terminal lugs N1 and N2 of the transfer mechanism, transfer switch is in the UTILITY position and source voltage is available to T1, T2 and customer load.
- ❏ Utility source voltage is available to limit switch (XA1) via the normally-closed transfer relay contacts (1 and 7) and Wire 126. However, XA1 is open and the Circuit to the utility closing coil is open.
- ❏ Utility voltage "sensing" signals are delivered to a circuit board on the generator, via Wire N1A, a 5 amp fuse (F1), transfer switch terminal N1, generator terminal N1 and a sensing transformer. The second line of the utility voltage "sensing" circuit is via Wire N2A, a 5 amp Fuse (F2), transfer switch terminal N2, generator terminal N2, and the sensing transformer.



Transfer Switch in Utility Position

Utility Voltage Available - *N1, N2*

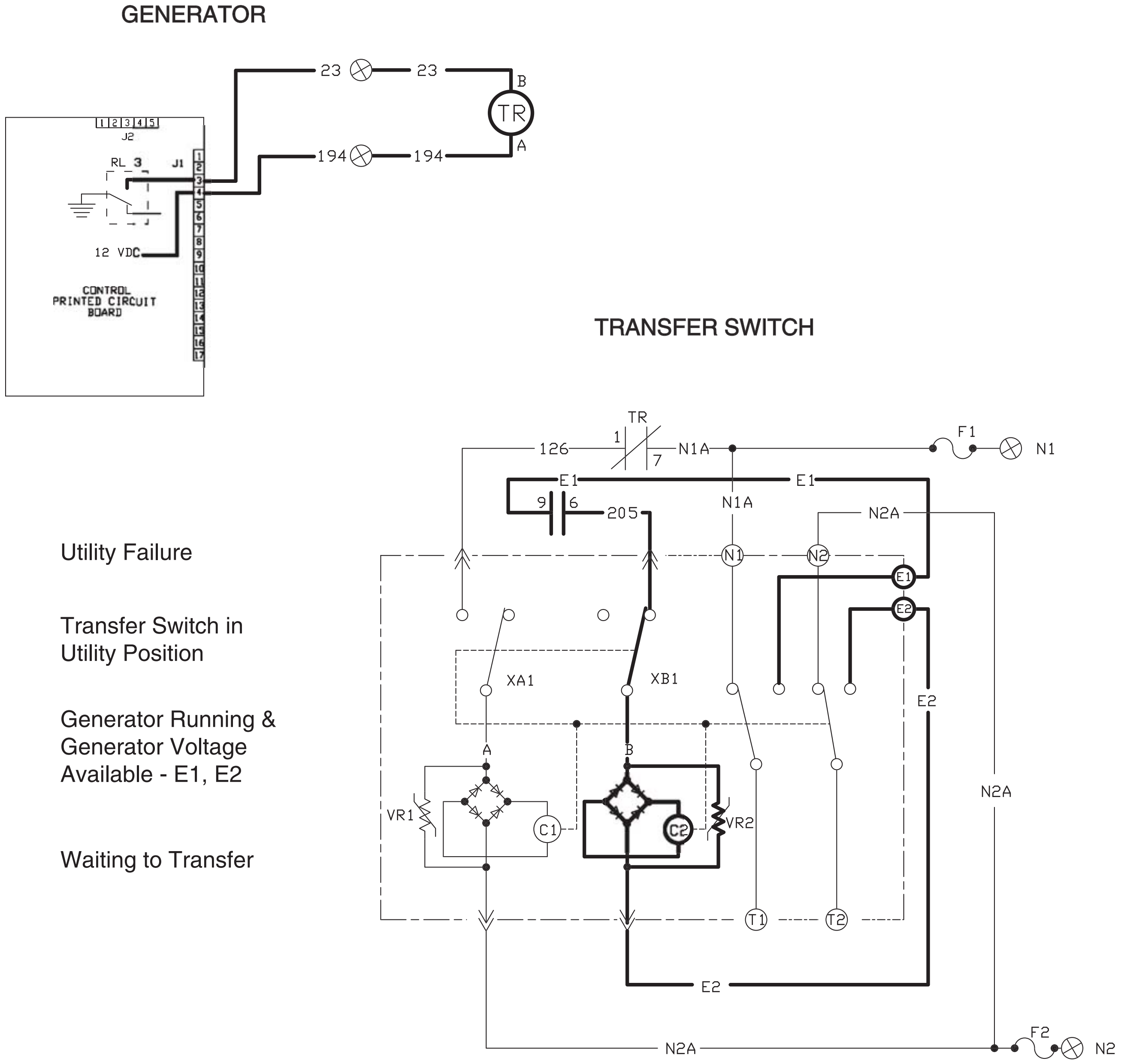
*Figure 2. Utility Source Power Available*

## *UTILITY SOURCE VOLTAGE FAILURE*

If utility source voltage should drop below a preset value, the generator circuit board will sense the dropout. That circuit board will then initiate generator cranking and startup after a time delay circuit times out.

Figure 3 is a schematic representation of the transfer switch with generator power available, waiting to transfer.

- ❏ Generator voltage available E1, E2.
- ❏ Circuit board action holding Wire 23 open to ground.
- ❏ Power available to standby coil C2, upon closure of TR, normally open contacts (9 & 6) will close and initiate a transfer.



Utility Failure

Transfer Switch in Utility Position

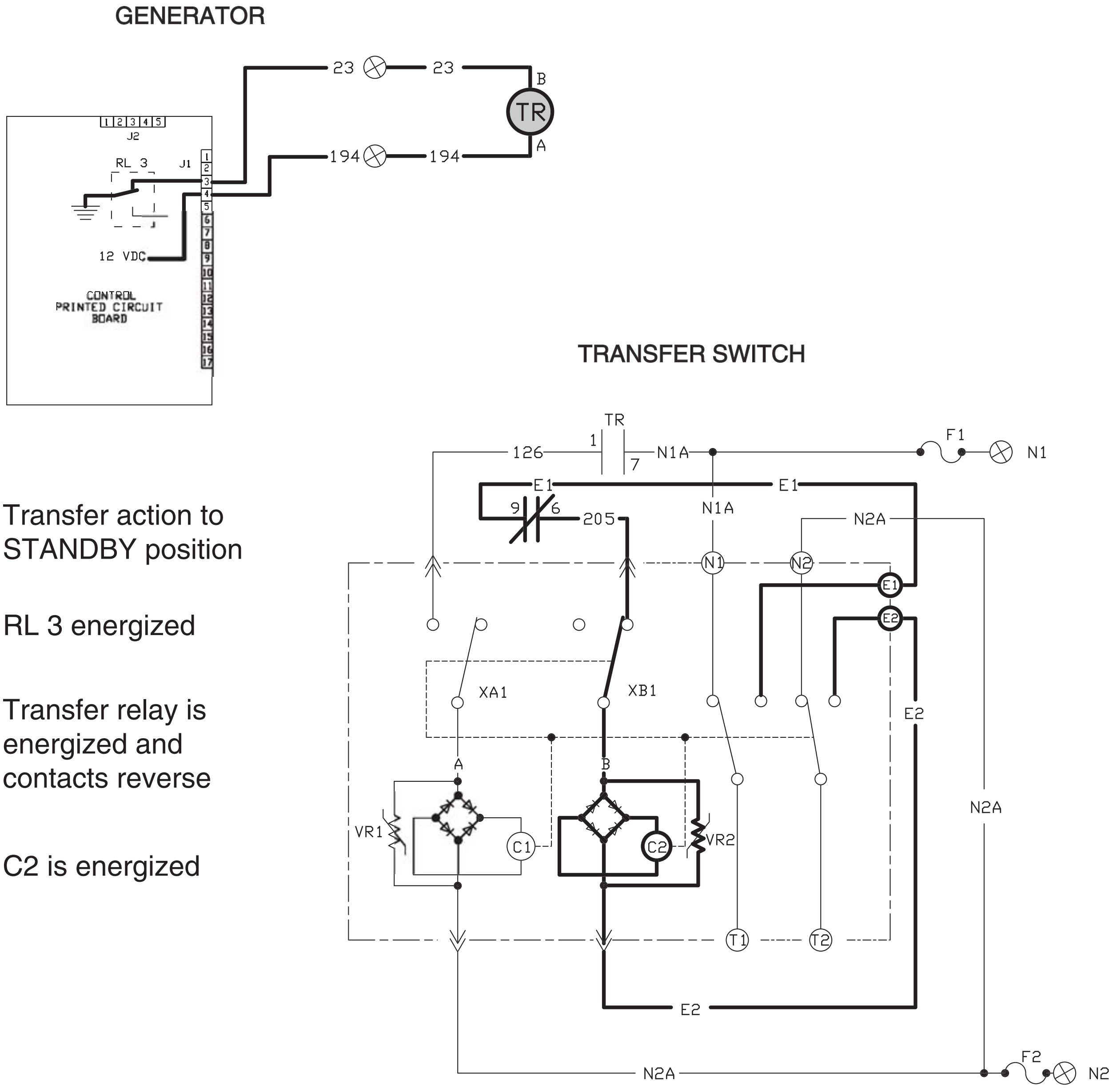
Generator Running & Generator Voltage Available - E1, E2

Waiting to Transfer

*Figure 3. Generator Power Available, Waiting to Transfer.*

## TRANSFER TO STANDBY

The generator circuit board delivers 12 volts DC to the transfer relay, via terminal 194 and back to the circuit board via terminal 23. However, circuit board action holds the Wire 23 circuit open and the transfer relay remains de-energized. On generator startup, an "engine warm-up timer" on the generator circuit board starts timing. When that timer has timed out, circuit board action completes the Wire 23 circuit to ground. The transfer relay then energizes, its normally open contacts close, and standby source voltage is delivered to the standby closing coil via Wires E1 and E2, the transfer relay (TR) contacts, limit switch (XB1), Wire "B". and a bridge rectifier. The standby closing coil energizes and the main contacts actuate to their "Standby" side.



Transfer action to STANDBY position

RL 3 energized

Transfer relay is energized and contacts reverse

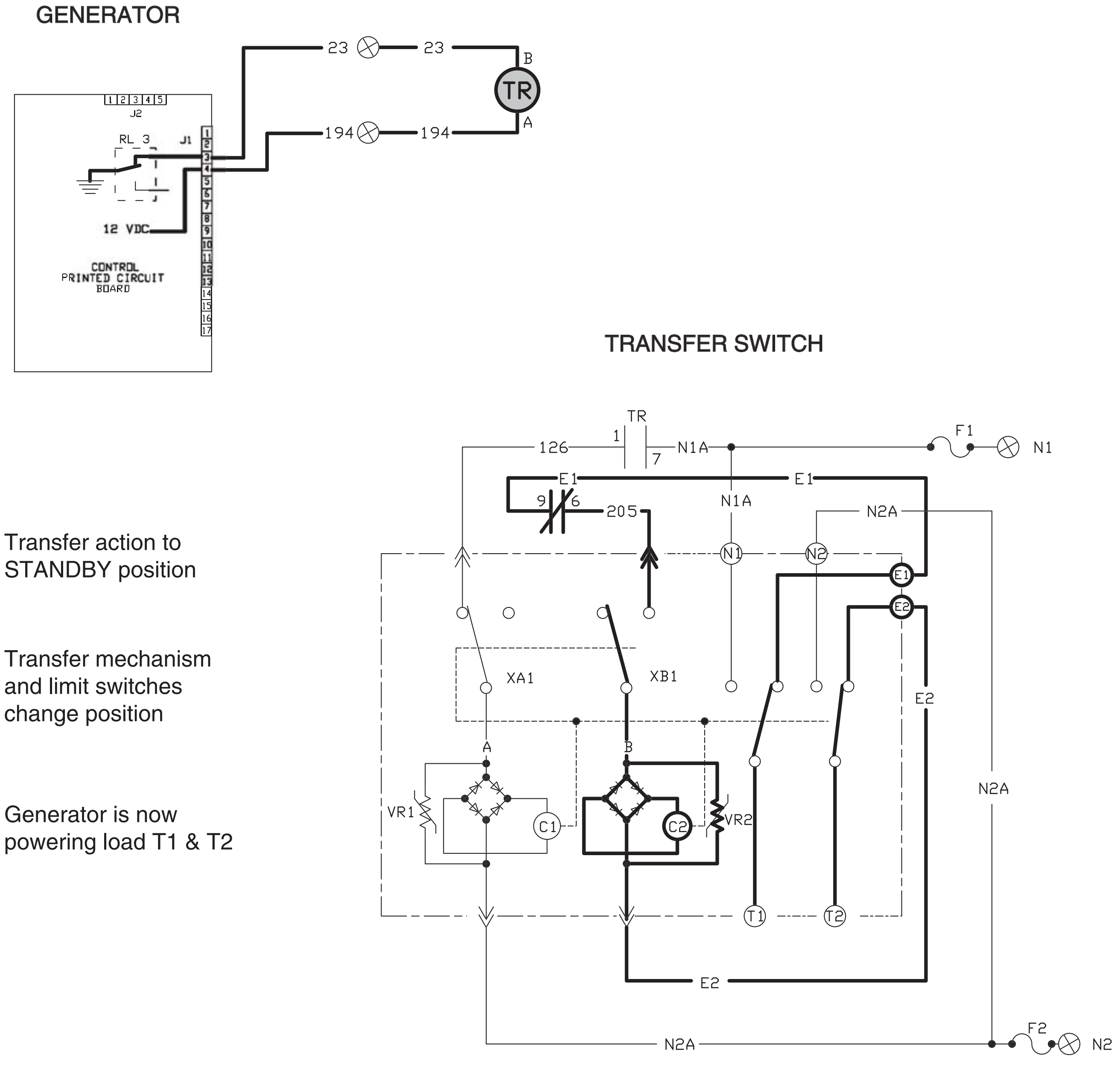
C2 is energized

*Figure 4. Transfer Action to Standby Position*

## *TRANSFER TO STANDBY*

When the standby coil is energized it pulls the transfer switch mechanism to a overcenter position towards the standby power source side, the transfer switch mechanically snaps to the STANDBY position. On closure of the main contacts to the standby power source side, limit switches XA1 and XB1 are mechanically actuated to "arm" the circuit for re- transfer to utility power source side.

Generator power from E1 and E2 is now connected to the customer load through T1 and T2.



Transfer action to STANDBY position

Transfer mechanism and limit switches change position

Generator is now powering load T1 & T2

*Figure 5. Generator Powering Load.*

## *UTILITY RESTORED*

Utility voltage is restored and is available to terminals N1 and N2. The utility voltage is sensed by the generators circuit board. If it is above a preset value for a preset time interval a transfer back to utility power will occur.

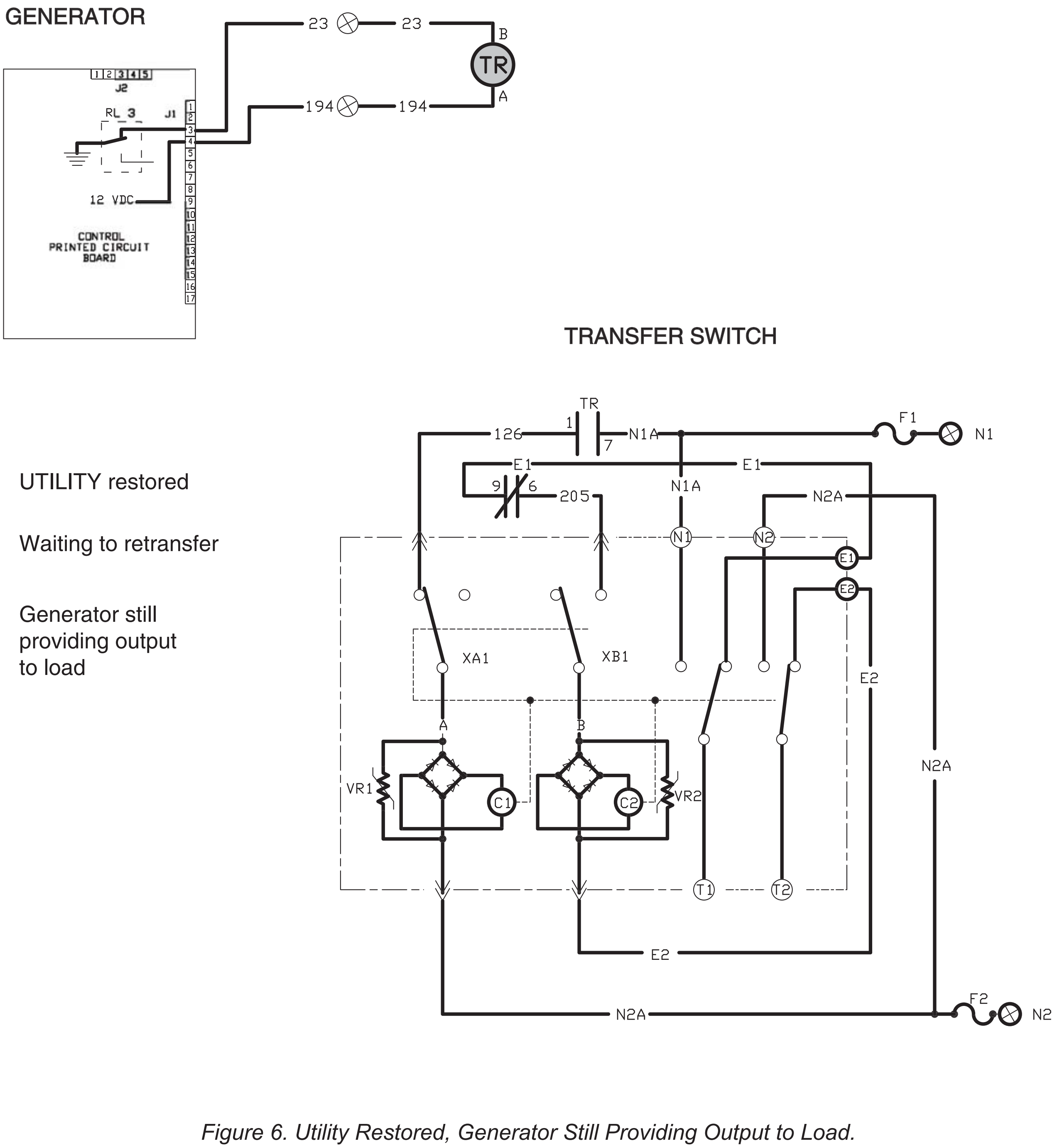
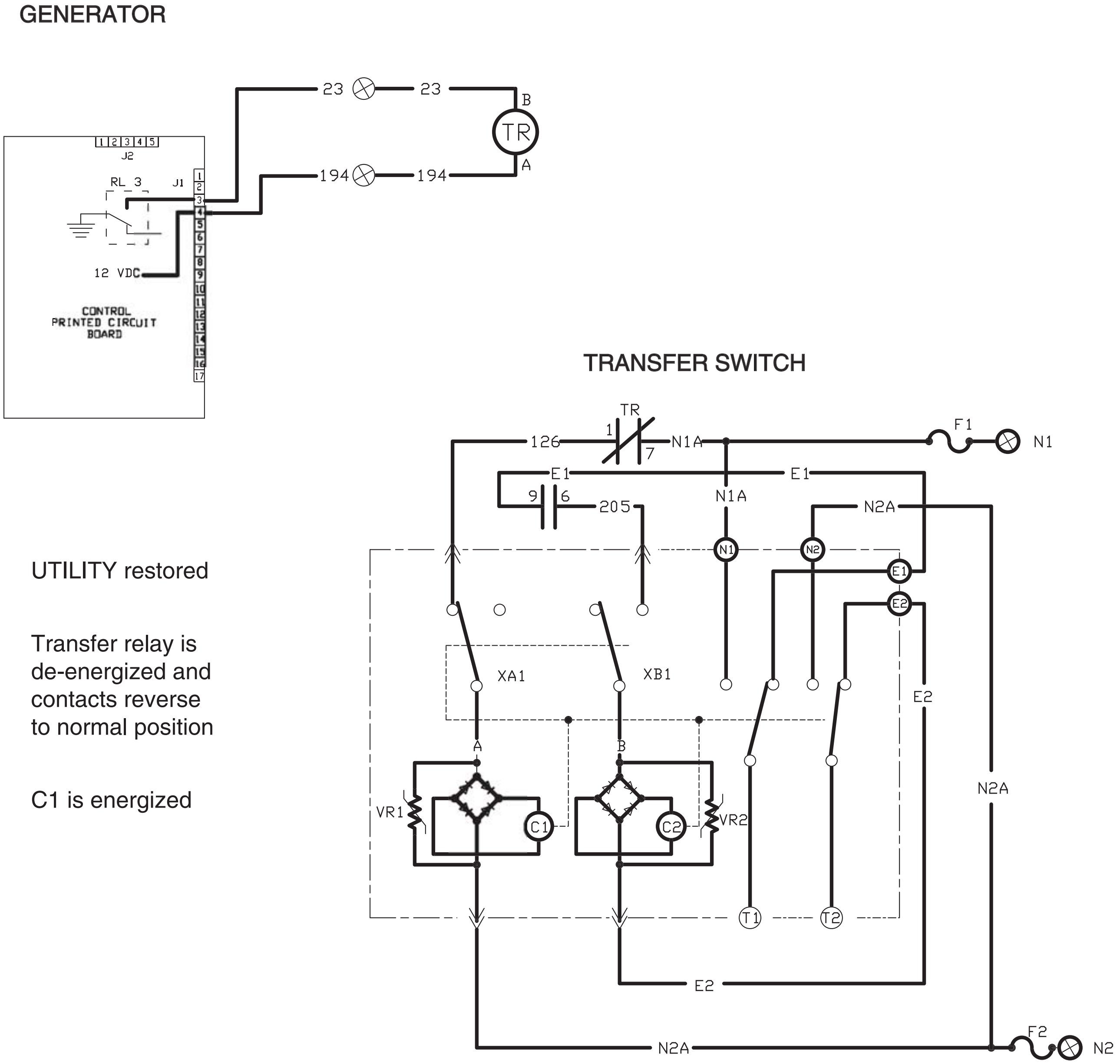


*Figure 6. Utility Restored, Generator Still Providing Output to Load.*

## *UTILITY RESTORED, TRANSFER SWITCH DE-ENERGIZED*

After the preset time interval expires the circuit board will open the Wire 23 circuit to ground. The transfer relay de-energizes, it's normally closed contacts close, and utility source voltage is delivered to the utility closing coil (C1), via Wires N1A and N2A, closed Transfer Relay Contacts 1 and 7, and Limit Switch XA1.



UTILITY restored

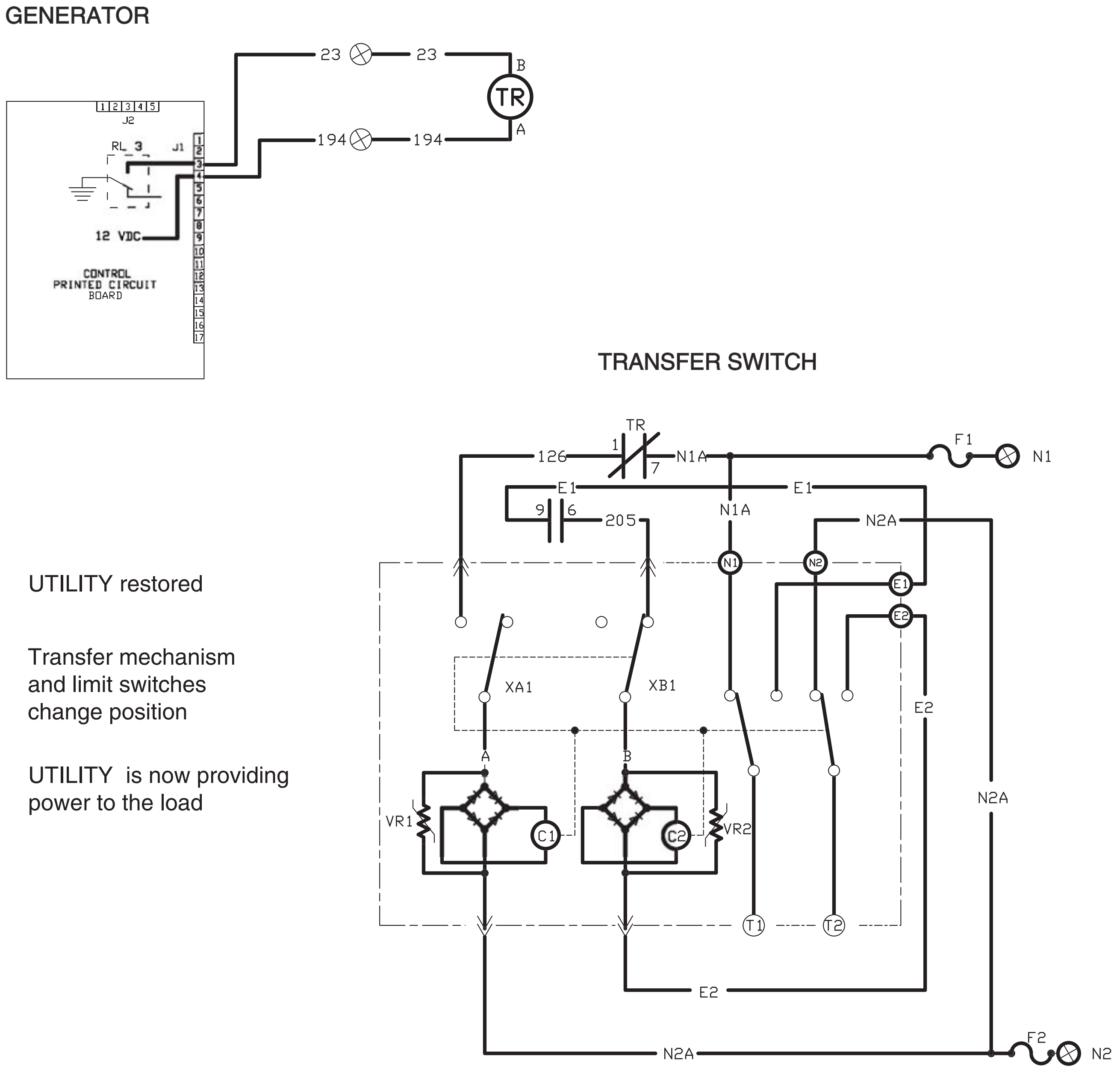
Transfer relay is de-energized and contacts reverse to normal position

C1 is energized

*Figure 7. Utility Restored, Transfer Relay De-energized.*

## *UTILITY RESTORED, RETRANSFER BACK TO UTILITY*

As the utility coil pulls the transfer switch to an OVER CENTER position, the switch mechanically snaps to UTILITY. On closure of the main contacts to the utility power source side, Limit Switches XA1 and XB1 are mechanically actuated to "arm" the circuit for transfer to STANDBY.



UTILITY restored

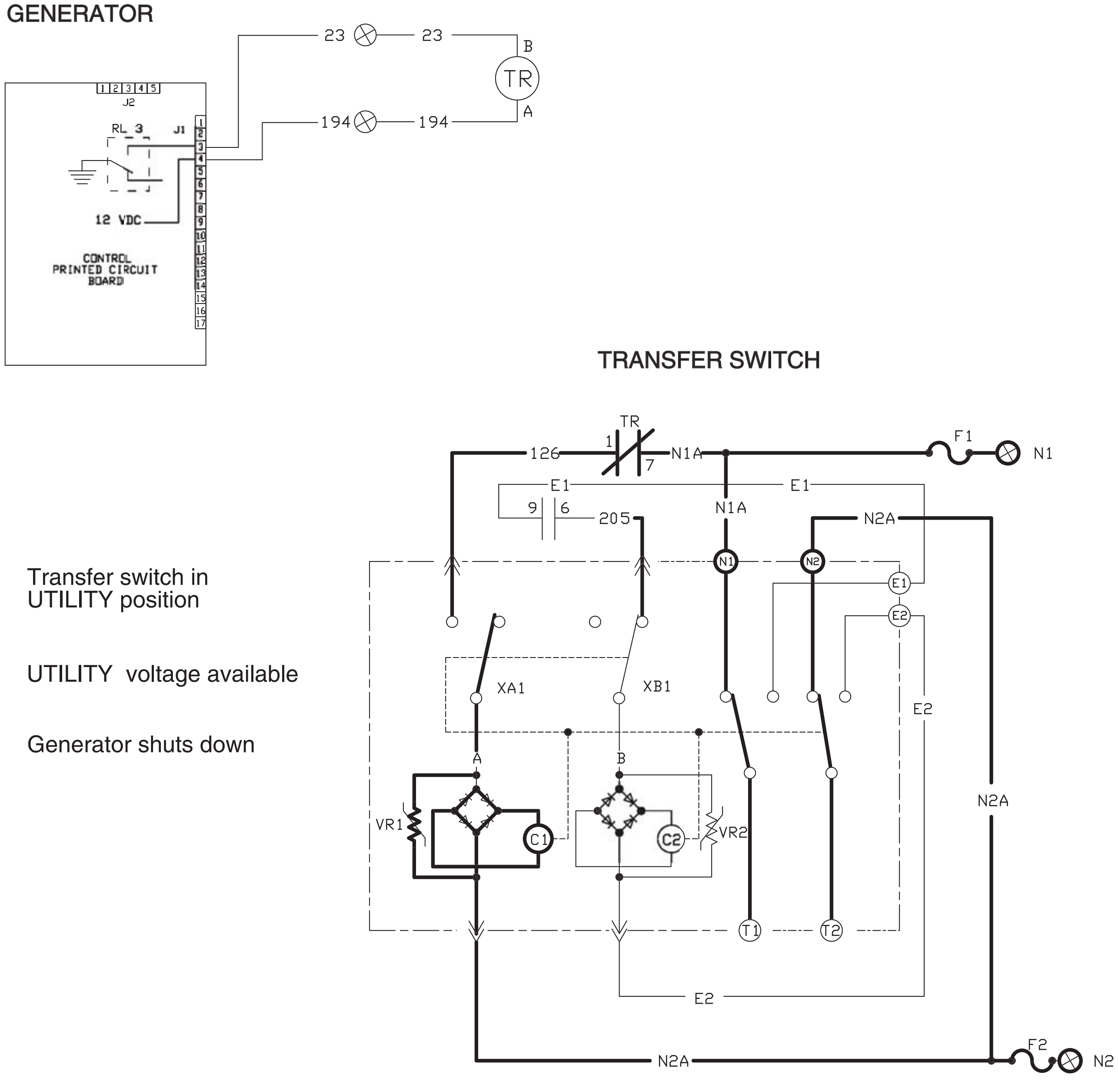
Transfer mechanism and limit switches change position

UTILITY is now providing power to the load

*Figure 8. Utility Restored, Retransfer Back to Utility.*

## TRANSFER SWITCH IN UTILITY

When the transfer switch returns to the UTILITY side, generator shutdown occurs after approximately one (1) minute.



Transfer switch in UTILITY position

UTILITY voltage available

Generator shuts down

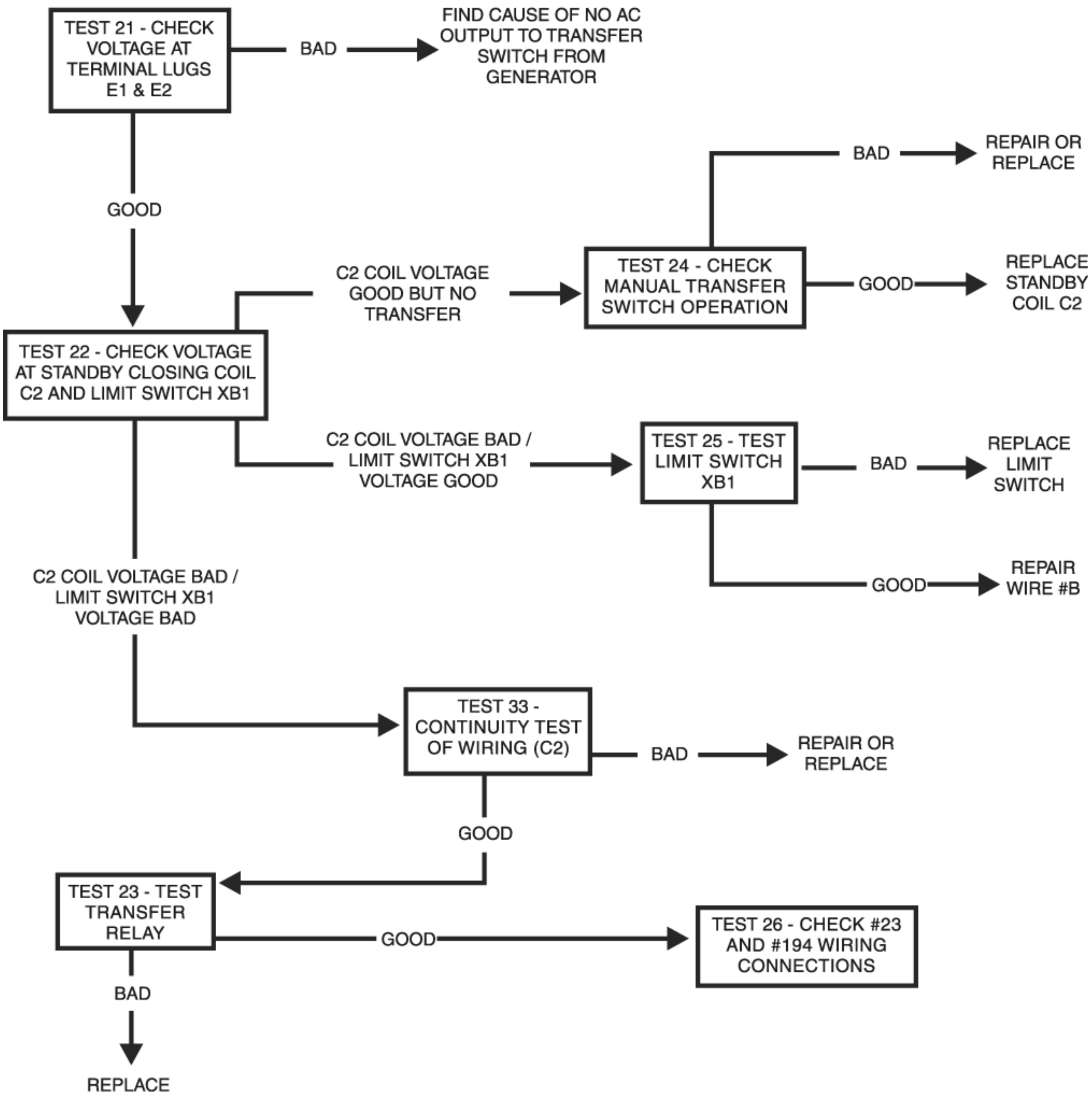
*Figure 9. Transfer Switch in UTILITY.*

## *INTRODUCTION TO TROUBLESHOOTING*

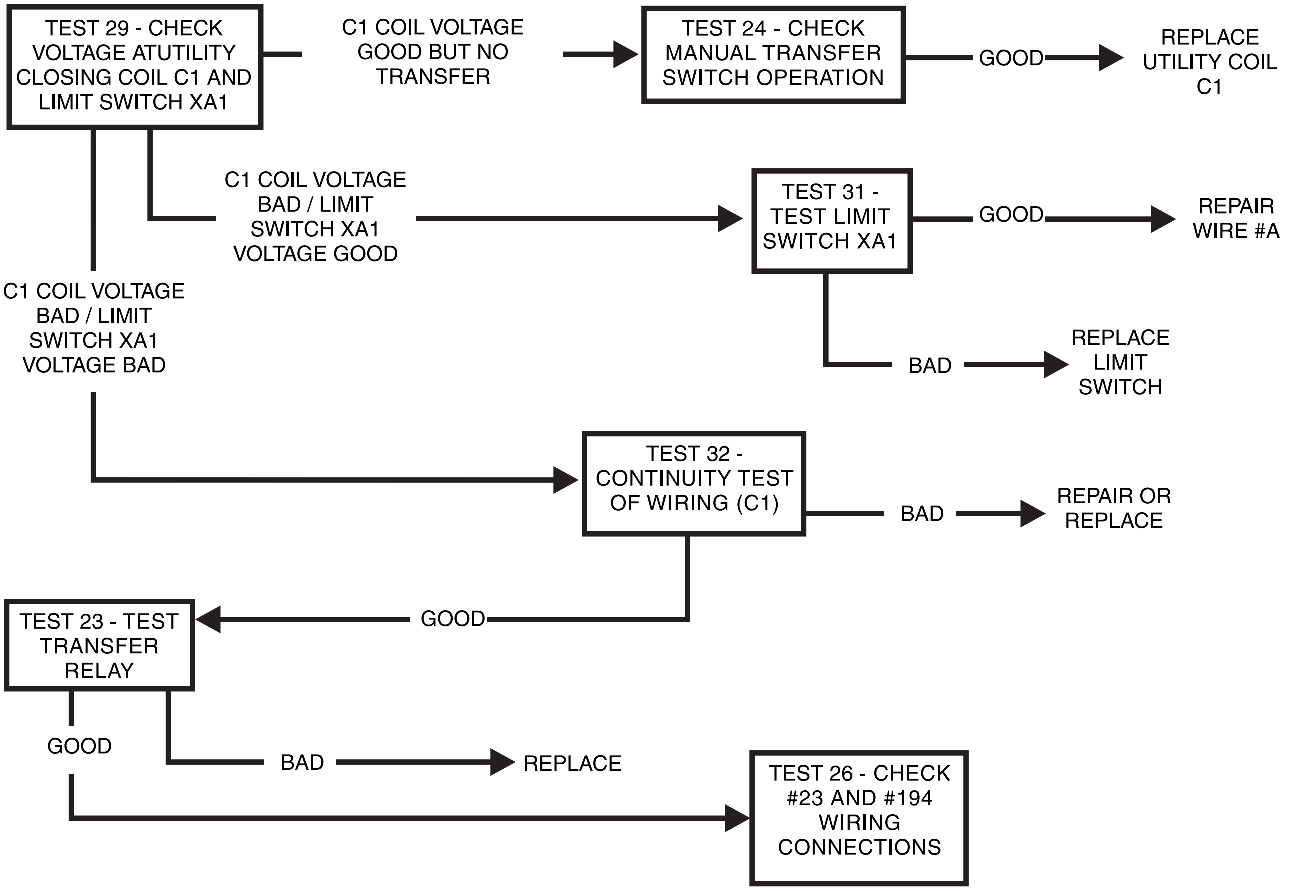
The first step in troubleshooting is to correctly identify the problem. Once that is done, the cause of the problem can be found by performing the tests in the appropriate flow chart.

Test numbers assigned in the flow charts are identical to test numbers in section 3.4, "Diagnostic Tests." Section

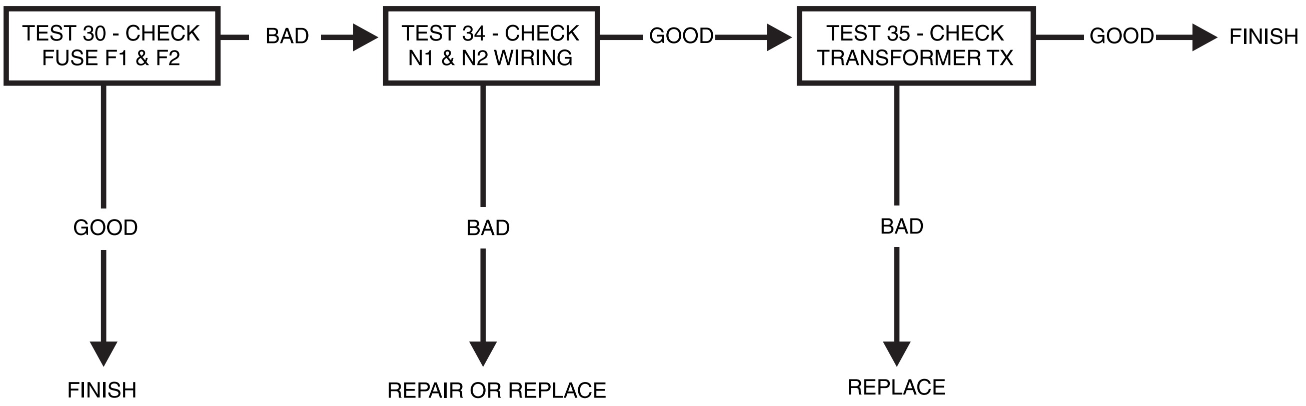
### Problem 5 - In Automatic Mode, No Transfer to Standby


TEST 21 - CHECK VOLTAGE AT TERMINAL LUGS E1 & E2
BAD
FIND CAUSE OF NO AC OUTPUT TO TRANSFER SWITCH FROM GENERATOR
GOOD
TEST 22 - CHECK VOLTAGE AT STANDBY CLOSING COIL C2 AND LIMIT SWITCH XB1
C2 COIL VOLTAGE GOOD BUT NO TRANSFER
TEST 24 - CHECK MANUAL TRANSFER SWITCH OPERATION
BAD
REPAIR OR REPLACE
GOOD
REPLACE STANDBY COIL C2
C2 COIL VOLTAGE BAD / LIMIT SWITCH XB1 VOLTAGE GOOD
TEST 25 - TEST LIMIT SWITCH XB1
BAD
REPLACE LIMIT SWITCH
GOOD
REPAIR WIRE #B
C2 COIL VOLTAGE BAD / LIMIT SWITCH XB1 VOLTAGE BAD
TEST 33 - CONTINUITY TEST OF WIRING (C2)
BAD
REPAIR OR REPLACE
GOOD
TEST 23 - TEST TRANSFER RELAY
GOOD
TEST 26 - CHECK #23 AND #194 WIRING CONNECTIONS
BAD
REPLACE

## *Problem 6 - In Automatic Mode, Generator Starts When Loss of Utility Occurs, Generator Shuts Down When Utility Returns But There Is No Retransfer To Utility Power*


TEST 29 - CHECK VOLTAGE ATUTILITY CLOSING COIL C1 AND LIMIT SWITCH XA1
C1 COIL VOLTAGE GOOD BUT NO TRANSFER
TEST 24 - CHECK MANUAL TRANSFER SWITCH OPERATION
GOOD
REPLACE UTILITY COIL C1
C1 COIL VOLTAGE BAD / LIMIT SWITCH XA1 VOLTAGE GOOD
TEST 31 - TEST LIMIT SWITCH XA1
GOOD
REPAIR WIRE #A
BAD
REPLACE LIMIT SWITCH
C1 COIL VOLTAGE BAD / LIMIT SWITCH XA1 VOLTAGE BAD
TEST 32 - CONTINUITY TEST OF WIRING (C1)
BAD
REPAIR OR REPLACE
GOOD
TEST 23 - TEST TRANSFER RELAY
GOOD
BAD
REPLACE
TEST 26 - CHECK #23 AND #194 WIRING CONNECTIONS

## *Problem 7 - Blown F1 or F2 Fuse*


TEST 30 - CHECK FUSE F1 & F2
BAD
TEST 34 - CHECK N1 & N2 WIRING
GOOD
TEST 35 - CHECK TRANSFORMER TX
GOOD
FINISH
GOOD
FINISH
BAD
REPAIR OR REPLACE
BAD
REPLACE

## GENERAL

Test numbers in this section correspond to the numbered tests in Section 3.3, "Troubleshooting Flow Charts". When troubleshooting, first identify the problem. Then, perform the diagnostic tests in the sequence given in the flow charts.

## TEST 21- CHECK VOLTAGE AT TERMINAL LUGS E1, E2

DISCUSSION:

In automatic mode, the standby closing coil (C2) must be energized by standby generator output if transfer to the "Standby" source is to occur. Transfer to "Standby" cannot occur unless that power supply is available to the transfer switch.

**DANGER: BE CAREFUL! HIGH AND DANGEROUS VOLTAGES ARE PRESENT AT TERMINAL LUGS E1 AND E2 WHEN THE GENERATOR IS RUNNING. AVOID CONTACT WITH HIGH VOLTAGE TERMINALS OR DANGEROUS AND POSSIBLY LETHAL ELECTRICAL SHOCK MAY RESULT. DO NOT PERFORM THIS VOLTAGE TEST WHILE STANDING ON WET OR DAMP GROUND, WHILE BAREFOOT, OR WHILE HANDS OR FEET ARE WET.**

PROCEDURE:

1. If the generator engine has started automatically (due to a utility power source outage) and is running, check the position of the generator main circuit breaker. The circuit breaker must be set to its "On" or "Closed" position. When you are sure the generator main circuit breaker is set to "On" or 'Closed", check the voltage at transfer mechanism terminal lugs E1 and E2 with an accurate AC voltmeter or with an accurate volt-ohm-milliammeter (VOM). The generator line-to line voltage should be indicated.
2. If the generator has been shut down, proceed as follows:
   a. On the generator control panel, set the AUTO-OFF-MANUAL switch to OFF.
   b. Turn OFF all power voltage supplies to the transfer switch. Both the utility and standby power supplies must be positively turned off before proceeding.
   c. Check the position of the transfer mechanism main contacts. The moveable LOAD contacts must be connected to the stationary UTILITY source contacts. If necessary, manually actuate the main contacts to the "Utility" power source side.

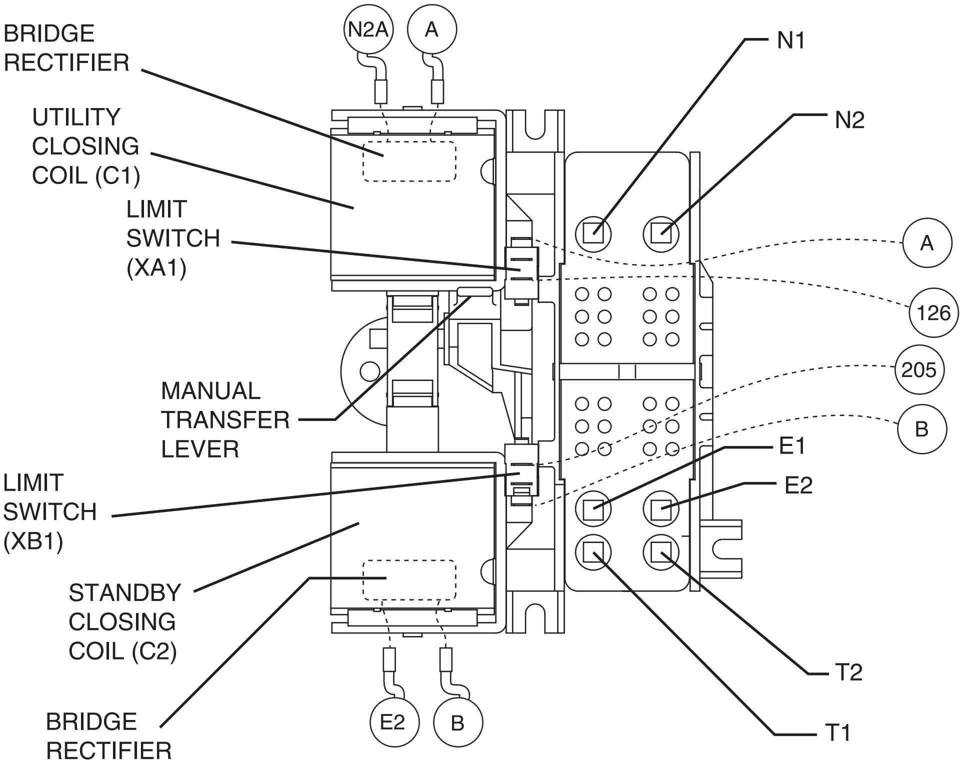


Figure 1. The "V-Type" Transfer Mechanism

d. Actuate the generator main line circuit breaker to its "On" or "Closed" position. The utility power supply to the transfer switch must be turned OFF.

e. Set the generator AUTO-OFF-MANUAL switch to AUTO.

  (1) The generator should crank and start.

  (2) When the generator starts, an "engine warm-up timer" should start timing. After about 15 seconds, the transfer relay should energize and transfer to the "Standby" source should occur.

f. If transfer to "Standby" does NOT occur, check the voltage across transfer switch terminal lugs E1 and E2. The generator line-to-line voltage should be indicated.

RESULTS:

1. If normal transfer to "Standby" occurs, discontinue tests.
2. If transfer to "Standby" does NOT occur and no voltage is indicated across terminal lugs E1/E2, determine why generator AC output has failed.
3. If transfer to "Standby" does NOT occur and voltage reading across terminal lugs E1/E2 is good, go on to Test 22.

### *TEST 22 - CHECK VOLTAGE AT STANDBY CLOSING COIL C2*

DISCUSSION:

Standby source voltage is used to energize the standby closing coil and actuate the main contacts to their "Standby" source side. Standby source alternating current (AC) is changed to direct current (DC) by a bridge rectifier before reaching the closing coil. This test will determine if standby voltage is available to the closing coil.

If normal standby source voltage is available to the terminals of the standby closing coil but transfer to "Standby" does NOT occur, look for (a) binding or sticking in the transfer mechanism, (b) a defective coil, or (c) a bad bridge rectifier. The coil and the bridge rectifier must be replaced as a unit.

PROCEDURE:

1. Set the generator main line circuit breaker to the OFF or "Open" position.
2. Set the generators AUTO-OFF-MANUAL switch to the OFF position.
3. Set your VOM to measure AC voltage.

**DANGER: BE CAREFUL! HIGH AND DANGEROUS VOLTAGES ARE PRESENT AT TERMINAL LUGS WHEN THE GENERATOR IS RUNNING. AVOID CONTACT WITH HIGH VOLTAGE TERMINALS OR DANGEROUS AND POSSIBLY LETHAL ELECTRICAL SHOCK MAY RESULT. DO NOT PERFORM THIS VOLTAGE TEST WHILE STANDING ON WET OR DAMP GROUND, WHILE BAREFOOT, OR WHILE HANDS OR FEET ARE WET.**

4. Disconnect Wire E2 from the standby closing coil (C2). Connect one meter test Lead to Wire E2. Use a suitable and safe connection to this wire, such as an alligator clip that attaches to the meter test probe. Isolate this wire and test probe from any other potential source or ground.
5. If necessary, repeat Step 2 under "Procedure" of Test 21. The system must be in automatic operating mode, with engine running, and standby source voltage available to terminal lugs E1 and E2.
6. Locate on the standby closing coil the terminal that Wire B is connected to. (Figure 1, previous page). Connect the other meter test lead to this terminal. Generator line to line voltage should be indicated. If generator voltage is NOT indicated, proceed to Step 7.
7. With Wire E2 still connected to one test probe, connect the other meter test lead to Wire 205 on Limit Switch XB1(see Figure 1 on previous page). Generator line to line voltage should be measured.

RESULTS:

1. If generator line-to-line voltage is indicated in "Procedure, Step 6," but transfer does NOT occur, proceed to Test 24.
2. If generator line-to-line voltage is NOT indicated in "Procedure, Step 7," proceed to Test 33.
3. If generator line-to-line voltage is indicated in "Procedure, Step 7," proceed to Test 25.

## *TEST 23 - TEST TRANSFER RELAY TR*

DISCUSSION:

In automatic operating mode, the transfer relay must be energized by circuit board action or standby source power will not be available to the standby closing coil. Without standby source power, the closing coil will remain de-energized and transfer to "Standby" will not occur. This test will determine if the transfer relay is functioning normally.

PROCEDURE:

1. See Figure 2. Disconnect all wires from the transfer relay, to prevent interaction.
2. Set a VOM to its "R x 1" scale and zero the meter.
3. Connect the VOM test leads across Relay Terminals 6 and 9 with the relay de-energized. The VOM should read INFINITY.

| CONNECT VOM TEST LEADS ACROSS | DESIRED METER READING | |
|---|---|---|
| | ENERGIZED | DE-ENERGIZED |
| Terminals 6 and 9 | Continuity | Infinity |
| Terminals 1 and 7 | Infinity | Continuity |

4. Using jumper wires, connect the positive (+) post of a 12 volt battery to relay Terminal "A" and the negative (-) battery post to Relay Terminal "B". The relay should energize and the VOM should read CONTINUITY.

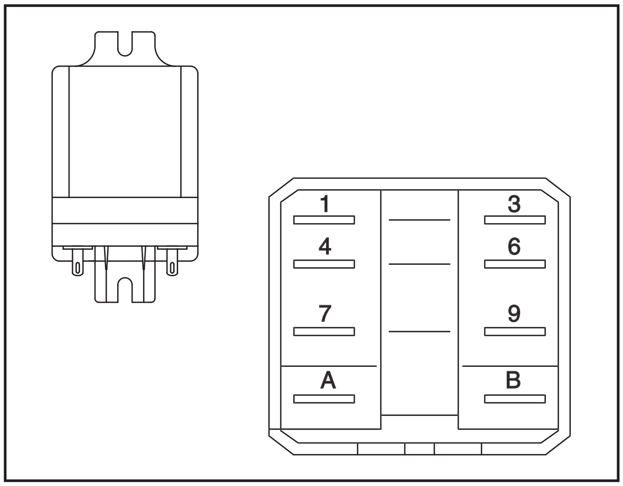


*Figure 2. Transfer Relay Test Points*

5. Now, connect the VOM test leads across Relay Terminals 1 and 7.
   a. Energize the relay and the meter should indicate INFINITY.
   b. De-energize the relay and the VOM should read CONTINUITY.

RESULTS:

1. Replace transfer relay if it is defective.
2. If transfer relay checks good go to Test 26.

## *TEST 24- CHECK MANUAL TRANSFER SWITCH OPERATION*

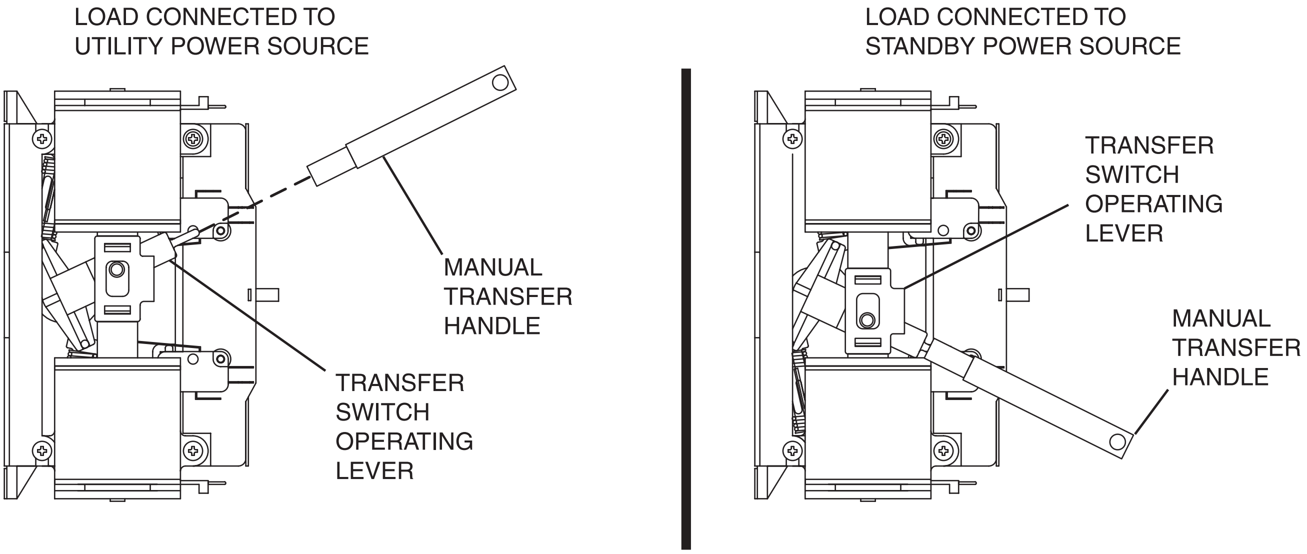


*Figure 3. Manual Transfer Switch Operation*

DISCUSSION:

In automatic operating mode, when utility source voltage drops below a preset level, the engine should crank and start. On engine startup, an "engine warm-up timer" on the generator circuit board should start timing. When that timer has timed out (about 15 seconds), the transfer relay should energize to deliver utility source power to the standby closing coil terminals. If normal utility source voltage is available to the standby closing coil terminals, but transfer to STANDBY does not occur, the cause of the failure may be (a) a failed standby closing coil and/or bridge rectifier, or (b) a seized or sticking actuating coil or load contact. This test will help you evaluate whether any sticking or binding is present in the transfer mechanism.

PROCEDURE:

1. With the generator shut down, set the generator AUTO-OFF-MANUAL switch to OFF.
2. Set the generator main circuit breaker to OFF or "Open".
3. Turn off the utility power supply to the transfer switch, using whatever means provided (such as a utility source main line breaker).

**DANGER: DO NOT ATTEMPT MANUAL TRANSFER SWITCH OPERATION UNTIL ALL POWER VOLTAGE SUPPLIES TO THE SWITCH HAVE BEEN POSITIVELY TURNED OFF. FAILURE TO TURN OFF ALL POWER VOLTAGE SUPPLIES MAY RESULT IN EXTREMELY HAZARDOUS AND POSSIBLY LETHAL ELECTRICAL SHOCK.**

4. In the transfer switch enclosure, locate the manual transfer handle. Handle is retained in the enclosure with a wing nut. Remove the wing nut and handle.
5. See Figure 3. Insert the un-insulated end of the handle over the transfer switch operating lever.
   a. Move the transfer switch operating lever up to actuate the load contacts to the UTILITY position, i.e., load connected to the utility source.
   b. Actuate the operating lever down to move the load contacts against the standby contacts, i.e., load connected to the STANDBY source.
6. Repeat Step 5 several times. As the transfer switch operating lever is moved slight force should be needed until the lever reaches its center position. As the lever moves past its center position, an over-center spring should snap the moveable load contacts against the stationary STANDBY or UTILITY contacts.
7. Finally, actuate the main contacts to their UTILITY power source side, i.e., load contacts against the UTILITY contacts (upward movement of the operating lever).

RESULTS:

1. If there is no evidence of binding, sticking, excessive force required, replace the appropriate closing coil.
2. If evidence of sticking, binding, excessive force required to move main contacts, find cause of binding or sticking and repair or replace damaged part(s).

### *TEST 25- TEST LIMIT SWITCH XB1*

DISCUSSION:

Standby power source voltage must be available to the standby closing coil in order for a TRANSFER TO STANDBY action to occur. To deliver that source voltage to the coil, limit switch XB1 must be closed to the "Standby" power source side. If the limit switch did not get actuated or has failed open, the source voltage will not be available to the closing coil and transfer to "Standby" will not occur.

PROCEDURE:

With the generator shut down, the generator main circuit breaker turned OFF, and with the utility power supply to the transfer switch turned OFF, test limit switch XB1 as follows:

1. To prevent interaction, disconnect Wire 205 and Wire B from the limit switch terminals.
2. Set a VOM to its "R x 1" scale and zero the meter.
3. See Figure 1. Connect the VOM test probes across the two outer terminals from which the wires were disconnected.
4. Manually actuate the main contacts to their "Standby" position. The meter should read INFINITY.
5. Manually actuate the main contacts to their UTILITY position. The meter should read CONTINUITY.
6. Repeat Steps 4 and 5 several times and verify the VOM reading at each switch position.

RESULTS:

1. If Limit Switch XB1 fails the test, remove and replace the switch or adjust switch until it is actuated properly.
2. If limit switch is good, repair or replace Wire B between limit switch and Standby Coil (C2).

## *TEST 26 - CHECK 23 AND 194 WIRING/CONNECTIONS*

DISCUSSION:

An open circuit in the transfer switch control wiring can prevent a transfer action from occurring. In the auto mode, the circuit board supplies +12 VDC to Wire 194. This DC voltage is supplied to the transfer relay (TR) at Terminal Location "A". The opposite side of the transfer relay (TR) coil (Terminal B) is connected to Wire 23. Positive 12VDC is present on this also. Circuit board action will allow current to flow through the circuit and the (TR) is energized.

PROCEDURE/RESULTS:

1. Set VOM to DC volts
2. Place generator AUTO-OFF-MANUAL switch to the AUTO position. Utility power should be present; the generator should not start.
3. Connect the negative (-) test lead to a suitable frame ground in the transfer switch.
4. Connect the positive (+) test lead to Wire 194 at the terminal strip in the transfer switch.
   a. If voltage is present, proceed to Step 5.
   b. If voltage is NOT present, proceed to Step 9.
5. Connect the positive (+) test lead to Wire 23 at the terminal strip in the transfer switch.
   a. If voltage is present, proceed to Step 6.
   b. If voltage is NOT present, repair wiring between terminal strip and transfer relay (TR).
6. Connect the negative (-) test lead to the ground lug in the generator control panel. Connect the positive (+) test lead to Wire 23 in the generator control panel at the interconnection terminals (ICT) or at the terminal strip.
   a. If voltage is present, proceed to Step 7.
   b. If voltage is NOT present, repair wiring between transfer switch and generator control panel.
7. Connect the positive (+) test lead to Wire 23 located in the J1 connector Pin Location 3, connected to the circuit board (see Figure 3, Page 4.1-2).
   a. If voltage is present, proceed to Step 8.
   b. If voltage is NOT present, repair wiring between (ICT and J1connector).
8. Turn off utility power to transfer switch, simulating a utility failure.
   a. Generator starts and transfer occurs, discontinue tests.
   b. Generator starts and transfer does NOT occur. With the generator running and utility OFF, ground Wire 23 in the control panel at interconnection terminals (ICT) or at the terminal strip. If transfer occurs replace circuit board.
9. Connect the negative (-) test lead to the ground lug in the generator control panel. Connect the positive (+) test lead to Wire 194 in the generator control panel at the interconnection terminals (ICT) or at the terminal strip.
   a. If the voltage is present, repair wiring between ICT (or terminal strip) and transfer switch
   b. If voltage is NOT present, proceed to Step 10.
10. Connect the positive (+) test lead to Wire 194 located in the J1 connector Pin Location 4, connected to the circuit board (see Figure 3, Page 4.1-2).
    a. If voltage is present, repair wiring between J1 connector and ICT (or terminal strip).
    b. If voltage is NOT present, replace circuit board.

## *TEST 27- CHECK VOLTAGE AT TERMINAL LUGS N1, N2*

DISCUSSION:

If retransfer to the "Utility" power source side is to occur, utility source voltage must be available to terminal lugs N1 and N2 of the transfer mechanism. In addition, If that source voltage is not available to NI/N2 terminals, automatic startup and transfer to "Standby" will occur when the generator manual-off-auto switch is set to AUTO. This test will prove that "Utility" voltage is available to those terminals, or is not available. It is the first test in a series of tests that should be accomplished when (a) retransfer back to 'Utility" does not occur, or (b) startup and transfer occurs unnecessarily.

**DANGER: PROCEED WITH CAUTION! HIGH AND DANGEROUS VOLTAGES ARE PRESENT AT TERMINAL LUGS N1/N2. CONTACT WITH HIGH VOLTAGE TERMINALS WILL RESULT IN DANGEROUS AND POSSIBLY LETHAL ELECTRICAL SHOCK. DO NOT ATTEMPT THIS TEST WHILE STANDING ON WET OR DAMP GROUND, WHILE BAREFOOT, OR WHILE HANDS OR FEET ARE WET.**

PROCEDURE:

1. Make sure that all main line circuit breakers in the utility line to the transfer switch are "On" or "Closed."
2. Test for utility source line-to-line voltage across terminal lugs N1 and N2 (see Figure 1). Normal utility source voltage should be indicated.

RESULTS:

1. If low or no voltage is indicated, find the cause of the problem and correct.
2. If normal utility source voltage is indicated, go on to Test 28.
3. For Problem 14 ONLY, if voltage is good, repair or replace Wire N1A/N2A between Transfer Switch Lugs N1/N2 and Fuse Holder connections.

### *TEST 28 - CHECK VOLTAGE AT UTILITY 1 AND UTILITY 2 TERMINALS*

The UTILITY 1 and UTILITY 2 terminals in the transfer switch deliver utility voltage "sensing" to a circuit board. If voltage at the terminals is zero or low, standby generator startup and transfer to the "Standby" source will occur automatically as controlled by the circuit board. A zero or low voltage at these terminals will also prevent retransfer back to the "Utility" source.

PROCEDURE:

With utility source voltage available to terminal lugs N1 and N2, use an AC voltmeter or a VOM to test for utility source line-to-line voltage across terminal block "Utility 1" and "Utility 2" terminals. Normal line-to-line utility source voltage should be indicated.

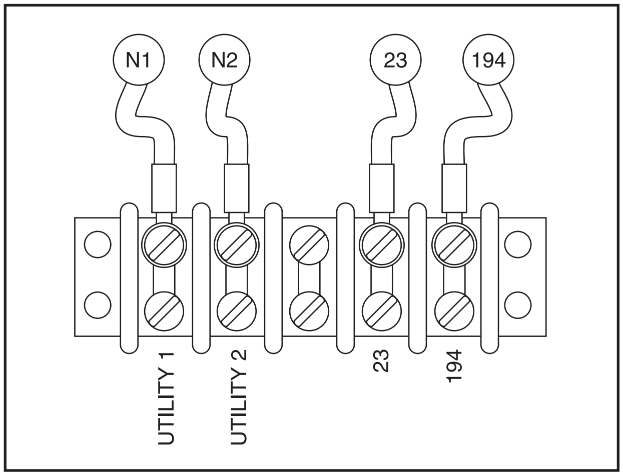


*Figure 4. Transfer Switch Terminal Block*

RESULTS:

1. If voltage reading across the "Utility I" and "Utility 2" terminals is zero, go to Test 30.
2. If voltage reading is good, go to Test 29.
3. For Problem 14 ONLY; if voltage is good, repair N1/N2 open wiring between Transfer Switch and Generator.

### *TEST 29- CHECK VOLTAGE AT UTILITY CLOSING COIL C1*

DISCUSSION:

Utility source voltage is required to energize utility closing coil C1 and effect retransfer back to the "Utility" source. This voltage is delivered to the utility closing coil via Wires N1A and N2A, the transfer relay's normally-closed contacts (relay de-energized), Wire 126, Limit Switch XA1, and a bridge rectifier.

PROCEDURE:

1. On the generator control panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn OFF the utility power supply to the transfer switch, using whatever means provided (such as a utility source main line circuit breaker).
3. Set the generator main line circuit breaker to its OFF or "Open" position.
4. Check the position of the transfer mechanism main contacts. The moveable load contacts must be connected to the stationary utility contacts. If necessary, manually actuate the main contacts to their "Utility source side (load connected to the "Utility' source).

**DANGER: BE CAREFUL! HIGH AND DANGEROUS VOLTAGES ARE PRESENT AT TERMINAL LUGS WHEN THE GENERATOR IS RUNNING. AVOID CONTACT WITH HIGH VOLTAGE TERMINALS OR DANGEROUS AND POSSIBLY LETHAL ELECTRICAL SHOCK MAY RESULT. DO NOT PERFORM THIS VOLTAGE TEST WHILE STANDING ON WET OR DAMP GROUND, WHILE BAREFOOT, OR WHILE HANDS OR FEET ARE WET.**

5. Disconnect Wire N2A from the utility closing coil (C1). Connect one meter test Lead to Wire N2A. Use a suitable and safe connection to this wire, such as an alligator clip that attaches to the meter test probe. Isolate this wire and test probe from any other potential source or ground.

6. Set the generator main line circuit breaker to its "On" or "Closed" position.
7. Set the generator AUTO-OFF-MANUAL switch to AUTO.
   a. The generator should crank and start.
   b. About 15 seconds after engine startup, the transfer relay should energize and transfer to the 'Standby" source should occur.
8. When you are certain that transfer to "Standby" has occurred, turn ON the utility power supply to the transfer switch. After a 15 seconds, retransfer back to the "Utility" source should occur.
9. Locate on the utility closing coil the terminal that Wire A is connected to (see Figure 1, Page 3.4-1). Connect the other meter test lead to this terminal. Generator line to line voltage should be indicated. If generator voltage is NOT indicated, proceed to Step 10.
10. With Wire N2A still connected to one test probe, connect the other meter test lead to Wire 126 on Limit Switch XA1 (see Figure 1, Page 3.4-1). Generator line to line voltage should be measured.

RESULTS:

1. In Step 7, if the generator does NOT crank or start, refer to Part 4, "DC Control".
2. In Step 7, if transfer to the "Standby" source does NOT occur, go to Problem 1.
3. In Step 9, if normal utility source line-to-line voltage is indicated but retransfer back to "Utility" does NOT occur, go to Test 24.
4. If normal utility source line-to-line voltage is NOT indicated in Step 9, but is indicated in Step 10, proceed to Test 31.
5. If normal utility source line-to-line voltage is NOT indicated in Step 8, and is NOT indicated in Step 9, proceed to Test 32.

### TEST 30 - CHECK FUSES F1 AND F2

DISCUSSION:

Fuses F1 and F2 are connected in series with the Utility 1 and Utility 2 circuits, respectively. A blown fuse will open the applicable circuit and will result in (a) generator startup and transfer to "Standby", or (b) failure to retransfer back to the UTILITY source.

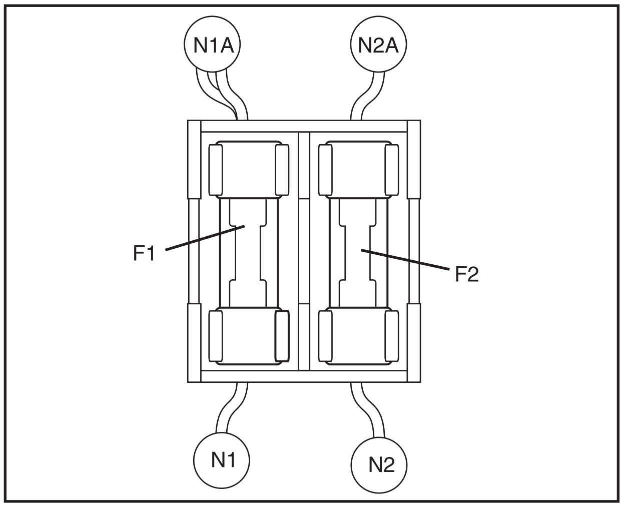


*Figure 5. Fuse Holder and Fuses*

PROCEDURE:

1. On the generator panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn off the utility power supply to the transfer switch, using whatever means provided.
3. Remove fuses F1 and F2 from the fuse holder (see Figure 5).
4. Inspect and test fuses for blown condition.

RESULTS:

1. Replace blown fuse(s) and proceed to Test 34.
2. For Problem 7 (DC Control section), go to Test 27.

### TEST 31 - TEST LIMIT SWITCH XA1

DISCUSSION:

When the transfer switch main contacts are actuated to their "Utility" position, limit switch XA1 should be mechanically actuated to its open position. On transfer to the "Standby" position, the limit switch should actuate to its closed position. If the switch does not actuate to its closed position, retransfer back to "Utility" will not occur.

PROCEDURE:

1. With the standby generator shut down, set its AUTO-OFF-MANUAL switch to OFF.
2. Turn OFF the utility power supply to the transfer switch, using whatever means provided.

3. To prevent interaction, disconnect Wire 126 and Wire "A" from the limit switch terminals.
4. Set a VOM to its "R x 1 " scale and zero the meter.
5. Connect the VOM test leads across the two limit switch terminals from which Wires A and 126 were removed.
6. Manually actuate the main contacts to their "Standby" position. The VOM should indicate CONTINUITY.
7. Manually actuate the main contacts to their "Utility" position. The VOM should read INFINITY.

RESULTS:

Replace limit switch XA1 if it checks bad.

***NOTE: Problems with transfer switch operation can also be caused by (a) defective wiring between the generator and transfer switch, or (b) a defective component in the generator circuit board. See Part 4, "DC Control".***

## *TEST 32 - CONTINUITY TEST OF WIRING (C1)*

DISCUSSION:

This test will ensure that all control wiring has continuity.

1. Set the AUTO-OFF-MANUAL switch to the OFF position.
2. Turn the generator main circuit breaker to the off position.
3. Turn off the utility power supply to the transfer switch using whatever means provided. (Such as utility source main line circuit breaker).
4. Set your VOM to the "R x 1" scale.
5. Disconnect Wire N2A from the Utility Coil C1 and connect one test lead to it. Connect the other test lead to terminal lug N2 of the transfer switch. CONTINUITY should be read. Reconnect Wire N2A.
6. Disconnect Wire 126 from transfer relay (TR) and connect one test lead to it. Connect the other test lead to limit switch XA1 bottom terminal Wire 126. CONTINUITY should be read. Reconnect Wire 126.
7. Disconnect Wire N1A from transfer relay (TR) terminal and connect one test lead to it. Connect the other test lead to F1 top fuse terminal Wire N1A. CONTINUITY should be read. Reconnect Wire N1A.

RESULTS:

Repair any defective wiring that does not read CONTINUITY. If wiring tests good, proceed to Test 23.

## *TEST 33 - CONTINUITY TEST OF WIRING (C2)*

DISCUSSION:

This test will ensure that all control wiring has continuity.

1. See Test 32, Step 1
2. See Test 32, Step 2
3. See Test 32, Step 3
4. See Test 32, Step 4
5. Disconnect Wire E2 from the standby coil (C2) and connect one test lead to it. Connect the other test lead to Terminal Lug E2 of the transfer switch. CONTINUITY should be read. Reconnect Wire E2.
6. Disconnect Wire 205 from transfer relay (TR) Terminal 6 and connect one test lead to it. Connect the other test lead to limit switch XB1 top terminal Wire 205. CONTINUITY should be read. Reconnect Wire 205.
7. Disconnect Wire E1 from Transfer Relay (TR) Terminal 9 and connect one test lead to it. Connect the other test lead to terminal lug E1 of the transfer switch. CONTINUITY should be read. Reconnect Wire E1.

RESULTS:

Repair any defective wiring that does not read CONTINUITY. If wiring tests good, proceed to Test 23.

## *TEST 34 - CHECK N1 AND N2 WIRING*

DISCUSSION:

A shorted Wire N1 or N2 to ground can cause fuse F1 or F2 to blow.

PROCEDURE:

1. On the generator panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn off the utility power supply to the transfer switch, using whatever means are provided.
3. Remove fuses F1 and F2 from the fuse holder (see Figure 5).
4. Remove the generator control panel cover. Disconnect wire N1 and wire N2 from the interconnection terminal in the control panel, or the terminal strip.
5. Set your VOM to the 'R x 1" scale. Connect the positive meter test lead to wire N1.
    a. Connect the negative meter lead to the ground lug. INFINITY should be measured.

   b. Connect the negative meter lead to Wire 23 at ICT or terminal strip. INFINITY should be measured.
   c. Connect the negative meter lead to Wire 194 at ICT or terminal strip. INFINITY should be measured.
   d. Connect the negative meter lead to the neutral connection. INFINITY should be measured.

6. Set your VOM to the 'R x 1" scale. Connect the positive meter test lead to wire N2.
   a. Connect the negative meter lead to the ground lug. INFINITY should be measured.
   b. Connect the negative meter lead to Wire 23 at ICT or terminal strip. INFINITY should be measured.
   c. Connect the negative meter lead to Wire No. 194 at ICT or terminal strip. INFINITY should be measured.
   d. Connect the negative meter lead to the neutral connection. INFINITY should be measured.
7. Disconnect wire N1 and wire N2 from transformer TX.
8. Connect one test lead to wire N1 removed in step 7, and the other test lead to the ground terminal. INFINITY should be measured.
9. Connect one test lead to wire N2 removed in step 7, and the other test lead to the ground terminal. INFINITY should be measured.
10. If no short is indicated in steps 5 through 9, proceed with steps 11 through 15. If a short is indicated in steps 5 through 9, repair shorted wiring.
11. Reconnect wires N1 and N2 to the interconnection terminal or terminal strip.
12. Replace fuses F1 and F2 in the fuse holder.
13. Turn on the utility power supply to the transfer switch using whatever means is provided.
14. Set VOM to measure AC voltage. Connect one test lead to wire N1 and the other test lead to wire N2. Utility line to line voltage should be measured.
15. Turn off the utility power supply to the transfer switch using whatever means is provided.

RESULTS:

If a short is indicated in steps 5 through 9, repair wiring and re-test. If utility line to line voltage is measured in Step 14, proceed to Test 35.

### *TEST 35 - CHECK TRANSFORMER (TX)*

DISCUSSION:

The transformer is a step down type and has two functions. It supplies approximately 16VAC to the control board for utility sensing. It also supplies approximately 16 VAC to the battery charger when utility is available for trickle charge. A shorted transformer can result in fuse F1 or F2 blowing.

PROCEDURE:

1. On the generator panel, set the AUTO-OFF-MANUAL switch to OFF.
2. Turn off the utility power supply to the transfer switch, using whatever means is provided.
3. See Figure 6. Disconnect Wires N1, N2, 224, 225, 224A, 225A from transformer (TX).
4. Set a VOM to the "R x 1" scale.
5. Connect one test lead to TX terminal 1. Connect the other test lead to TX terminal 5. Approximately 38.5 ohms should be measured
6. Connect one test lead to TX terminal 10. Connect the other test lead to TX terminal 9. Approximately 1.5 ohms should be measured.
7. Connect one test lead tot TX terminal 7. Connect the other test lead to TX terminal 6. Approximately 0.3 ohms should be measured.
8. Connect one test lead to TX terminal 1. Connect the other test lead to the transformer case. INFINITY should be measured.
9. Connect one test lead to TX terminal 7. Connect the other test lead to the transformer case. INFINITY should be measured.
10. Connect one test lead to TX terminal 9. Connect the other test lead to the transformer case. INFINITY should be measured.
11. Connect one test lead to TX terminal 1. Connect the other test lead to TX terminal 10. INFINITY should be measured.
12. Connect one test lead to TX terminal 1. Connect the other test lead to TX terminal 7. INFINITY should be measured.

13. Connect one test lead to TX terminal 10. Connect the other test lead t TX terminal 7. INFINITY should be measured.

RESULTS:

For steps 5, 6, and 7, replace transformer if an open is indicated, or if the resistance value indicated is zero. If the resistance value is not within the approximate range, proceed to test 65.

For steps 8 through 13, replace the transformer if it fails any of these steps.

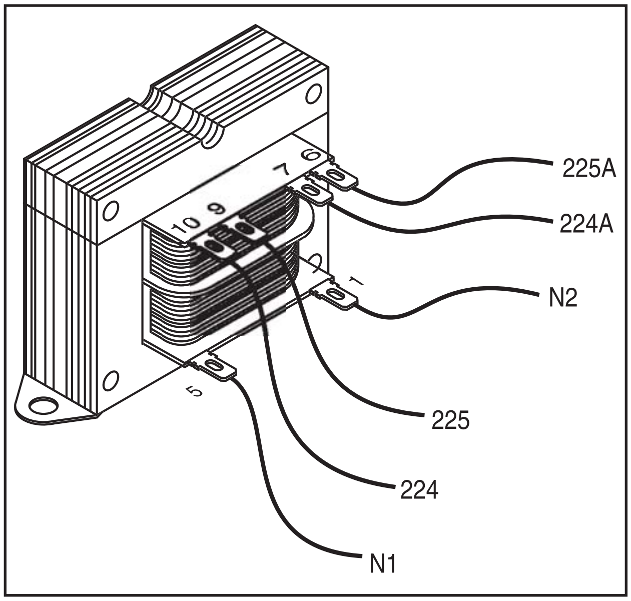


*Figure 6. Transformer (TX)*